CLAIMS

What is claimed is:

1. An embossing tool comprising:
   a transparent substrate;
   alignment features patterned on said transparent substrate for optically aligning said embossing tool with the substrate being embossed;
   an embossing material covering a center portion of said transparent substrate with clear regions near said alignment features; and,
   raised embossing features patterned in said embossing material, said features including a first height for trenches if any and a second height for vias if any.
2. The embossing tool of claim 1 wherein said alignment features are formed similarly to said embossing features.
3. The embossing tool of claim 1 wherein the material at the surface of said embossing features is nickel.
4. The embossing tool of claim 1 wherein the sidewalls of said embossing features have a positive taper angle of approximately 5 degrees to the normal.
5. The embossing tool of claim 3 wherein said nickel is coated with a mold release layer.
6. The embossing tool of claim 5 wherein said mold release layer is comprised of Cytop.
7. The embossing tool of claim 1 wherein one or more heating resistors are provided on said transparent substrate.
8. The embossing tool of claim 7 wherein one or more thermocouples are also provided on said transparent substrate.
9. The embossing tool of claim 7 wherein the material of said heating resistors is gold.
10. The embossing tool of claim 1 wherein said transparent substrate is a rectangular flat panel made of quartz.
11. The embossing tool of claim 1 and including embossing features in the form of guard rail features that circumscribe the other embossed features and protect them from compaction during embossing cycles.

12. A hot embossing tool comprising:
a substrate having embossing features; and,
a heating resistor fabricated on said substrate, underneath said embossing features.

13. A method for fabricating an embossing tool comprising the steps of:
providing a temporary substrate;
coating said temporary substrate with a photo-definable material;
exposing said photo-definable material in selected areas with a first exposure dose;
exposing said photo-definable material in selected areas with a second exposure dose;
developing said photo-definable material to create excavated features at said selected areas at depths predetermined by said exposure doses;
coating the surface including said excavated features with a seed layer of nickel;
electroplating said seed layer of nickel to create an irregularly filled surface;
polishing said irregular surface until planar, and the desired thickness of said electroplated nickel is achieved;
laminating a transparent substrate on top of said planar surface using a bonding material, keeping said bonding material clear of alignment features;
separating said transparent substrate with said nickel embossing features from said photo-definable material;
etching said nickel at said alignment features to create a light path through said electroplated nickel at each of said alignment features; and,
cleaning any remaining organic residues off the surface of said nickel embossing features.

14. An embossing machine or apparatus comprising:
a chamber enclosing an embossing tool and a substrate being embossed;
means for optically aligning said tool and said substrate; and,
means for applying a normal force between said embossing tool and said substrate to effect an embossing cycle, said alignment means and said force means being co-resident in said machine.

15. The embossing machine of claim 14 and including means to evacuate air from said chamber.

16. The embossing machine of claim 14 and including co-resident means for heating said embossing tool.

17. The embossing machine of claim 16 wherein said heating means is localized so as to heat only said tool and the topmost layer of said substrate.

18. The embossing machine of claim 14 and including means to detect the endpoint of said embossing cycle and thereby provide a limit stop for the application of said normal force.

19. A method of vapor assisted release of an embossing tool from a substrate being embossed comprising the steps of:

providing an imprintable material on said substrate that includes a volatile component;

applying a normal laminating force between said tool and said substrate during said imprint cycle;

using the release of said volatile component during an imprint cycle to provide a vapor-generated force between said tool and said substrate in opposition to said laminating force;

detecting the endpoint of said imprint cycle; and,

releasing said laminating force on said detection, allowing said vapor-generated force to separate said substrate from said tool without further action.

20. The method of claim 19 wherein said release of said volatile component is increased upon the application of heat to said imprintable material.

21. A method for preventing compaction or distortion of previously imprinted or fragile underlayers during an imprint cycle comprising the steps of:

providing a rail of rigid material at the periphery of each embossed layer;

providing adequate alignment such that the rail of each embossed layer will touch or interact with the corresponding rail of the previously embossed layer at the completion of said embossing cycle, thereby providing a limit stop; and,

terminating said imprint cycle when said limit stop is reached.

22. The method of claim 21 wherein the shape of said guard rails is sinusoidal and includes a phase offset of 180 degrees between the sinusoids of successive layers,

such that said guard rails will intersect and provide said limit stop, even with imperfect alignment between said successive layers.

23. The method of claim 21 wherein said rigid material is copper.

24. A method for selectively heating only the topmost layer of a stack of embossed layers during an embossing cycle, comprising the steps of:

providing a heating source near the embossing tool;

providing temperature sensors near said embossing tool;

determining an optimum temperature for the embossing features of said embossing tool, while imprinting said topmost layer during said embossing cycle;

controlling said heating source using data from said temperature sensors so as to maintain said optimum temperature of said embossing features during said embossing cycle; and,

arranging said embossing tool, said heating source, said temperature sensors, and said topmost layer such that heat is applied primarily to said topmost layer during said embossing cycle, and relatively small amounts of heat are applied to the other layers within said stack.